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EDITORIAL COMMENT

The Oculothrombotic Reflex

Why We Will Never Stop Aspirating Coronary Thrombi*

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In 1988 Topol coined the term "oculostenotic reflex" to describe the "irresistible temptation among some invasive cardiologists to perform angioplasty on any significant residual stenosis after thrombolysis" (1). Similarly, many operators find the temptation to aspirate thrombi irresistible, particularly when they sometimes extract magnificent red thrombi approaching the size of nightcrawlers (**Figure 1**). We propose that this phenomena be termed the "oculothrombotic reflex." Although the oculostenotic reflex has been widely condemned (2), the appropriateness of the oculothrombotic reflex is under debate. Recent reports have not been encouraging for aspiring aspirators.

THE STATE OF CORONARY THROMBUS ASPIRATION

Coronary thrombus aspiration (CTA) has been extensively tested in ST-elevation myocardial infarction (STEMI) patients undergoing primary percutaneous coronary intervention (PPCI). Early reports were favorable. CTA was associated with decreased mortality in randomized trials (3,4) and meta-analyses (5,6). However, more recent, larger trials (7,8) and meta-analyses (9,10) have found no improvement in clinical endpoints with CTA. As a consequence, an American College of Cardiology (ACC)/American Heart Association (AHA)/Society for Cardiac Angiography and Interventions (SCAI) guideline update published online in October 2015 downgraded *routine* CTA in STEMI from a IIa recommendation to a class III recommendation.

These negative findings are mirrored in large registries comparing nonrandomized use of CTA versus no CTA in PPCI in over 27,000 patients. Nor has CTA fared better in other acute coronary syndromes. The TATORT (Thrombus Aspiration in Thrombus Containing Culprit Lesions in Non-ST-Elevation Myocardial Infarction trial) found no benefit from CTA in percutaneous coronary intervention (PCI) for non-STEMI (11).

DELAYED CTA AND PCI IN STEMI

Current STEMI guidelines rate PPCI in the first 12 h as a class I recommendation, and PPCI 12 to 24 h after symptom onset with ongoing signs or symptoms of ischemia as a class IIa recommendation. The ACC/AHA/SCAI guidelines do not discuss PPCI after 24 h, but the most recent European Society of Cardiology guidelines upgraded PPCI at 12 to 48 h after symptom onset in STEMI to a IIb recommendation.

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With this background, in this issue of *JACC Cardiovascular Intervention,* Desch et al. (12) present the results of a randomized study of 152 STEMI patients presenting 12 to 48 h after the onset of symptoms who were randomized to CTA versus no CTA before PPCI. The primary endpoint was extent of microvascular obstruction as measured by cardiac magnetic resonance imaging. The secondary endpoints were surrogates of myocardial perfusion, including infarct size, myocardial salvage, left ventricular volumes, ejection fraction, myocardial blush grade, final thrombolysis in myocardial infarction flow, and clinical endpoints (for which the study was underpowered).

The investigators hypothesized that CTA might be more effective in delayed PPCI than in PPCI for STEMI at <12 h after the onset of symptoms. Older thrombi

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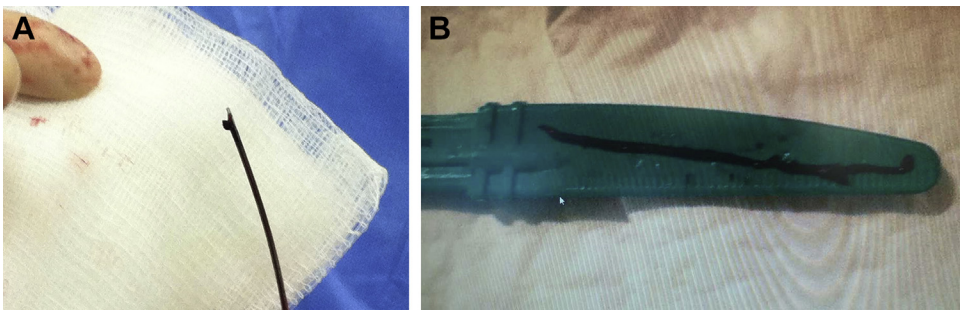
FIGURE 1 Coronary Thrombus Aspiration



(A) Coronary thrombus aspirated during primary percutaneous coronary intervention in a patient with ST-segment elevation myocardial infarction. The thrombus could not be fully aspirated into the catheter and was removed with suction applied to the catheter. The distal end of the thrombus is seen protruding from the aspiration lumen of the catheter. **(B)** The thrombus, more than 3 cm long, rests on a ruler.

are more consolidated and might be more likely to embolize downstream if mechanically impacted by an angioplasty balloon (13), thus obstructing collateral flow and causing additional infarction. The CTA of such thrombi might avoid downstream embolization. This might explain why, in the VAMPIRE (VAcuuM asPIration thrombus Removal) trial, which enrolled patients up to 24 h after the onset of symptoms, CTA had a more beneficial effect on markers of myocardial reperfusion in late presenters (>6 h) compared with early presenters (<6 h) (14).

Contrary to their hypothesis, for the primary endpoint and all secondary endpoints Desch et al. (12) found no significant differences between CTA and no CTA before PPCI.

In general, the study was well designed and well conducted. It was adequately powered for its primary endpoint. Cardiac resonance images were analyzed in an experienced core laboratory. Crossover between groups was low. The success rate of CTA in crossing the culprit lesions was 93%, better than reported in most other trials of CTA. It did have several weaknesses, including the following: 1) it was performed at a single center; 2) the interventionists were not blinded to the study assignments (although the patients and all other study personnel were blinded); 3) possibly too little viable myocardium remains after 12–48 h for any interventional strategy to show a benefit; and 4) the primary endpoint was a marker of reperfusion, a surrogate for clinical endpoints. (The clinical significance of surrogates is uncertain because several studies have demonstrated that CTA with PPCI improves surrogate outcomes without improving clinical outcomes [3,10,14–17].)

WILL THESE NEGATIVE RESULTS KILL CTA?

Recent editorialists, commenting on studies showing no clinical benefit of CTA, have opined that operators will continue to perform CTA. Why? Several reasons come to mind.

1. The oculothrombotic reflex. When operators see a large thrombus, the ease and intuitive appeal of CTA will continue to make it an attractive option.
2. CTA makes PPCI in STEMI easier. It allows more frequent direct stenting, which itself may decrease infarct size (18). Additionally, CTA may reduce distal embolization (14), saving operators the difficulty of chasing thrombi that embolize downstream and occlude the distal artery.
3. Studies provide evidence that *routine* CTA is not helpful, but *selective* CTA may be beneficial. Selective CTA with PPCI is a IIb recommendation in the ACC/AHA/SCAI STEMI guidelines published online in October 2015. Proponents of this view will cite 2 studies of patients with obvious thrombus randomized between CTA and no CTA before PPCI. One study found an improved myocardial salvage index and reduced infarct size in the CTA arm (14). The second study demonstrated that CTA improved the myocardial blush grade and microvascular obstruction (but not infarct size) (19). (Both studies were underpowered for clinical endpoints.)
4. Many randomized studies showed no difference in clinical outcomes with CTA (7,8,14,19), but others have suggested that CTA *did* improve clinical outcomes (3,15,20,21). Do interventionists in the Netherlands know how to perform CTA better than interventionists elsewhere, such that the large

TAPAS (Thrombus Aspiration during Percutaneous coronary intervention in Acute myocardial infarction Study) (3) showed a benefit for CTA? Most of these trials did not specify the CTA techniques, and operators may have developed individual tricks or techniques that are more successful than those used in the large trials.

SUMMARY

Routine CTA with PPCI appears to be discredited, and there is little hard evidence to support even *selective* CTA. However, interventionists are likely to continue to use CTA because of the oculothrombotic reflex, the visual gratification of occasionally extracting large thrombi from coronary arteries, and the sense that CTA makes STEMI PCI easier when a large thrombus burden is present. New technologies such as novel thrombus retrieval devices or the MGuard mesh stent (InspireMD, Boston, Massachusetts) may replace CTA in the future, but for now it seems clear that interventionists will retain CTA catheters in their toolkits.

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